Space Weather Technical Forecast

Issued on Tuesday, 05 July 2022 at 13:05 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Increasing chance of radio blackouts. Chance of Minor Geomagnetic Storms through midweek. Up to two CMEs pending analysis.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, however it showed a rising tendency, with background X-ray flux now nearing the boundary of C-class at GOES16.

The most significant events were a trio of C-class flares: firstly, an isolated C5.1 flare from AR3050 (now faded) at 04/1333UTC. This produced a Type II and IV radio burst signature and a dimming in AIA211. Secondly, a C5.8 at 05/0347UTC from a new unnumbered spot on the northeastern limb that currently presents as an Hhx/Alpha; and thirdly a C9.8 at 05/0407UTC from AR3047 in the southwest quadrant. This third flare also produced a Type II and IV radio burst along with a dimming in AIA 211. The spot responsible had been visually fading as a Bxo/Beta, and was otherwise unremarkable in the period.

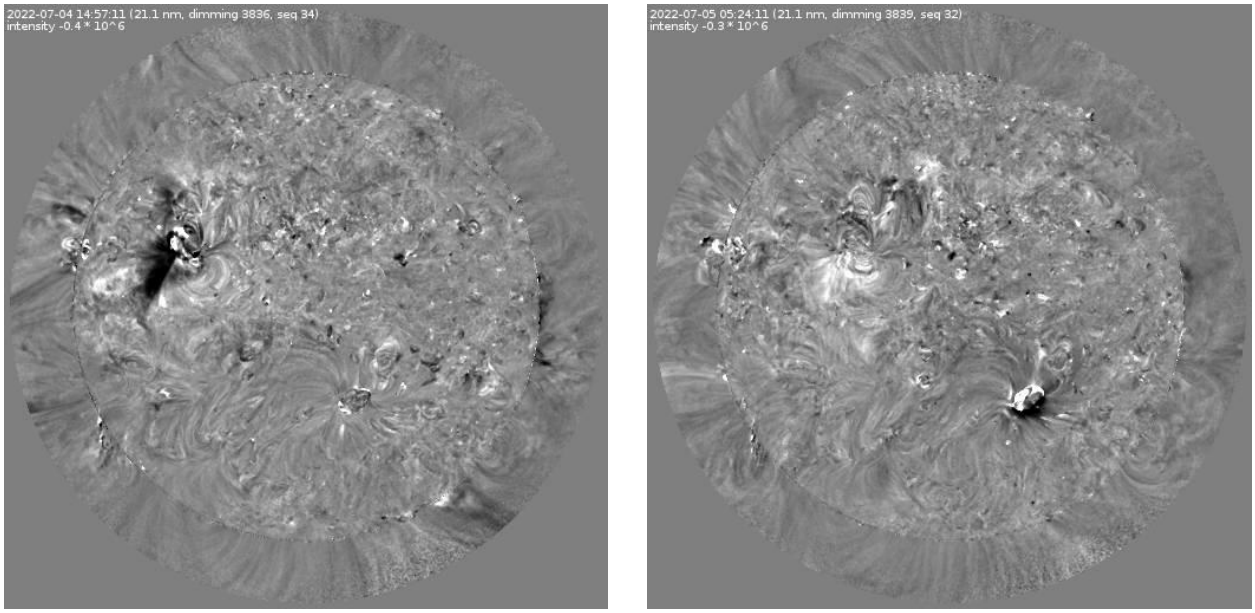

Figure 0a: Time-integrated AIA 211 imagery of the 04/1332UTC dimming from AR3050 (left); and 05/0407UTC AR3047 (right). Processing courtesy of SIDC ROB.

There were up to six sunspots on the disc, with all stable or in decay apart from a pair of Dro/Betas: AR3051 in the northeast, and a second new region in the same quadrant, with both showing development in their leading groups. Previously numbered AR3050 and AR3049 meanwhile, both faded to plage.

The two Type II signatures in the period were linked with possible speeds of 1828km/s and

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1255km/s respectively, which is perhaps surprisingly energetic for the associated flares. There is limited confirmatory imagery for both Coronal Mass Ejections (CMEs) at the time of writing. For the first candidate, there is a possible faint emission seen heading largely northeast, but this is far from a certain attribution and there is a significant gap in STEREO A COR2 imagery at this time for triangulation purposes.

For the second feature, Lasco C2 and STEREO A COR2 imagery is just becoming available, and appears to suggest ejecta heading slightly west of the Sun-Earth line, with a partial halo shock with a southwest-bias. This is too near the occulting disc to analyse fully yet but is an active area of monitoring.

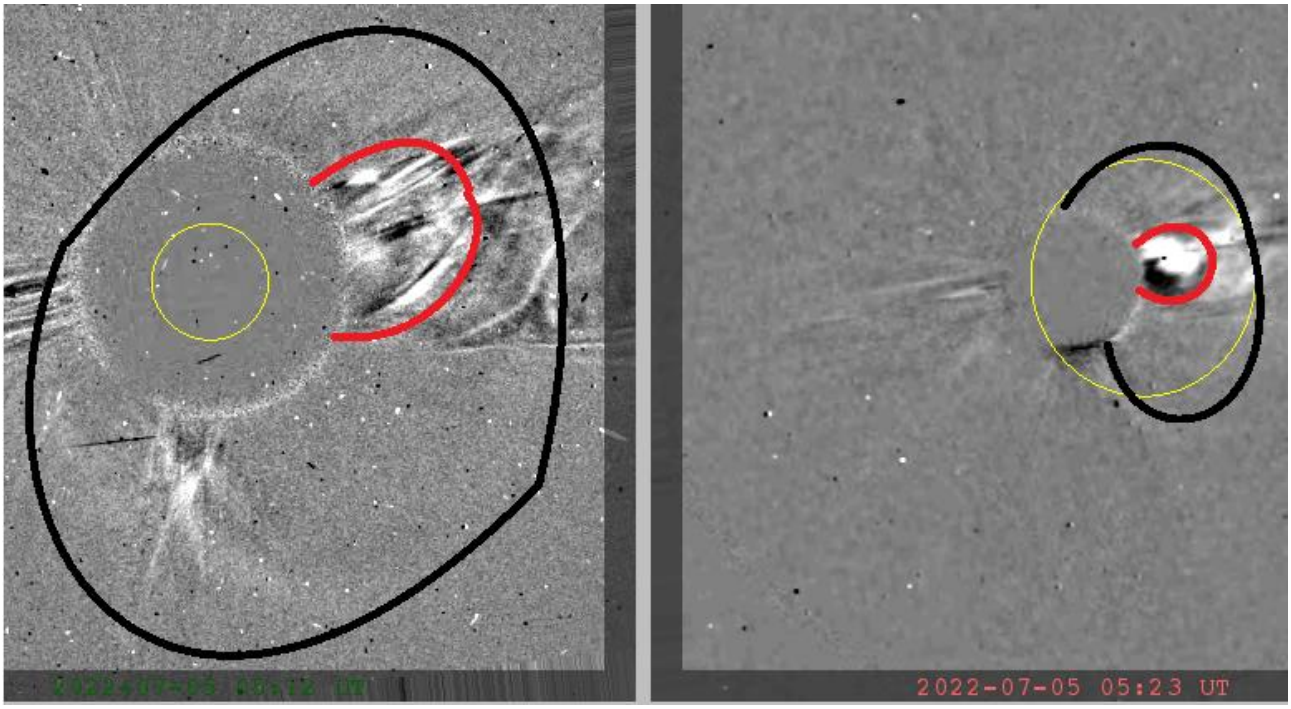

Figure 0b: Early-availability coronagraph difference imagery (Lasco C2 left, STEREO A COR2 right), showing shock in black and kernel of possible CME following the 05/0407UTC flare from AR3047. The shock at least appears as a partial halo.

Otherwise, the main feature on coronagraph imagery that was available was determined to be a slow event from behind the west limb (from an uncertain source). Updates to the CME situation will follow when available.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 by DSCOVR, suggested CME effects segueing into a slow solar wind environment. The solar wind speed fell from early highs near 490km/s to reach 375 by the period's end. The solar wind density also fell, from around 15ppcc to its typical residence of mid-single figures ppcc. The IMF peaked for a time at 15nT, with the north-south component varying between +13 and -10nT in a slow, roughly sinusoidal oscillation, with the IMF envelope then shrinking back to typical slow wind magnitude (around 5nT) after 04/2100UTC. The phi angle was predominantly negative (towards the sun).
The net effect of the above solar wind measures was a marked reduction in activity through the period, with provisional Unsettled to Active Kp ending 04 July becoming Quiet into the fifth, with a peak of Kp 4o in the 15-18UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16 remained at Background levels throughout the period.

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The high energy electron flux (greater than 2MeV) has been predominantly at Normal Background levels through the last 24 hours. Electron fluence was well below the Active (1e8 integrated pfu) threshold. Observed fluence was 1.27e6 integrated pfu at 05/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Expected to be Low, now with an increased daily Slight Chance of isolated M-class flares. A further increase is probable from the middle of the week as returning regions potentially cross onto the eastern limb.

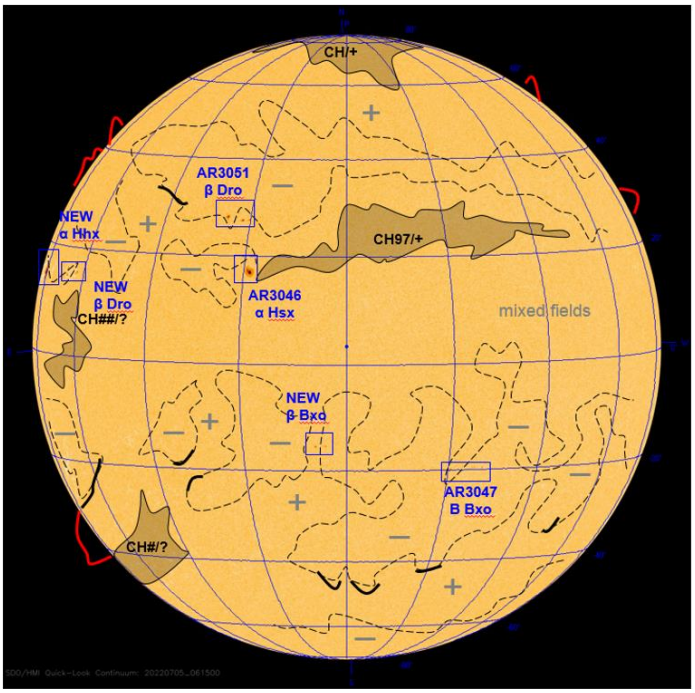
Solar Wind / Geomagnetic Activity: There is a possible slow CME from 29 June that may glance Earth on Day 1 (05 July), however no significant impacts are anticipated. There are then up to two unassessed CME candidates from the aforementioned Type II-generating sunspots, with analysis pending imagery availability.

Otherwise, solar winds are anticipated to increase from normal background to elevated levels as CH97/+ becomes geoeffective, perhaps most likely midweek. Late in the period solar winds should trend downwards again.

Energetic Particles / Solar Radiation: In the absence of any significant sunspot development, the high energy proton flux (greater than 10 MeV) is expected to remain at Background levels.

High energy electron flux (greater than 2MeV) is expected to be mainly Normal Background at first. However, there is a likely increasing chance of high (1e3 pfu) flux levels being reached during the forecast period due to anticipated high speed stream influence. Electron fluence is considered most likely to remain below the Active (1e8 integrated pfu) threshold, but with an anticipated rising trend.

Figure 1. Solar Analysis Valid 05/0615UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is a possible slow CME from 29 June that may glance Earth on Day 1 (05 July), however no significant impacts are anticipated given the lengthy transit time, and this feature will have in all likelihood have been subsumed in recent CME-related effects.

There are then up to two unassessed CME candidates from the aforementioned Type II-generating sunspots, with analysis pending imagery availability. The former is perhaps the less likely of the two to carry any Earth-bound component for being smaller, from the eastern solar hemisphere and also from a more limb-ward location relative to its western counterpart. Coronagraph images are unfortunately lacking for a significant portion of the relevant time window at the time of writing for STEREO A, while Lasco has some earlier minor debris that may complicate any attempt at plane-of-sky analysis should one be required. Updates will follow.

Otherwise, solar winds are anticipated to increase from normal background to elevated levels as CH97/+ becomes geoeffective, perhaps most likely midweek, although recent STEREO A data is not conclusively showing any enhancement inside two days, perhaps very slightly exacerbated by a lower orbital latitude relative to the sun's equator (with CH97/+ in the northern solar hemisphere). Late in the period solar winds should trend downwards again, although this hypothesis does rely on a midweek onset.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	30	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/1903	Partial	Filament	N18W000	200km/s	05 July	Very low confidence

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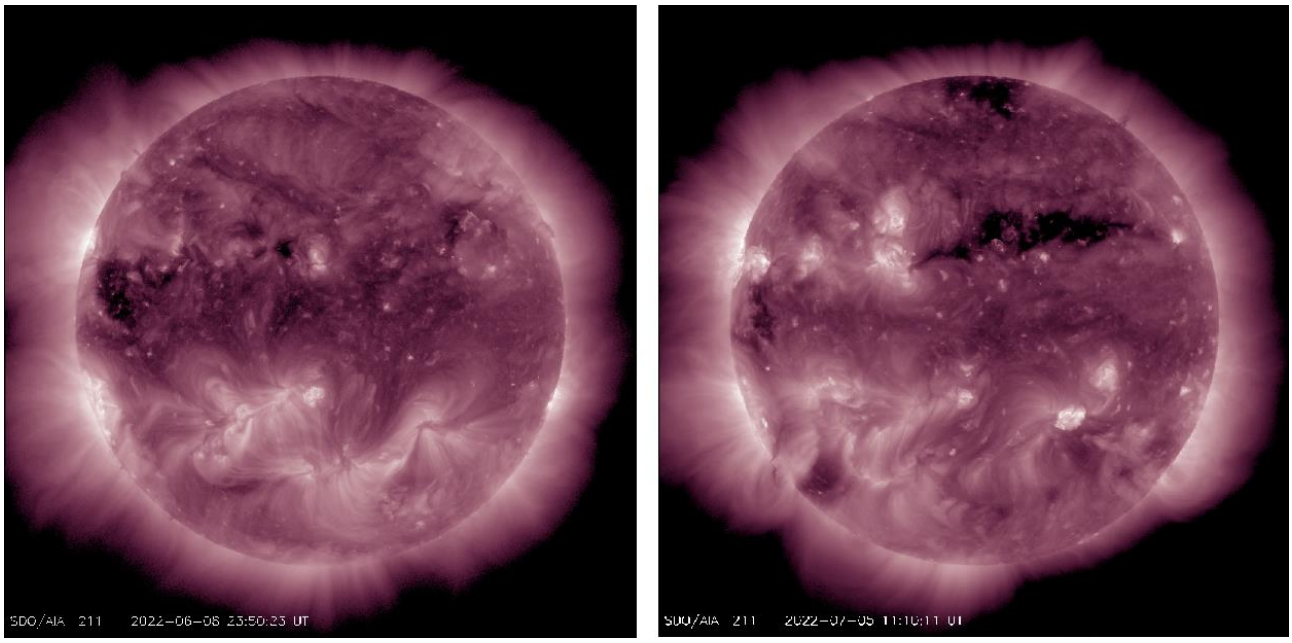
Figure 2: AIA 211 imagery from 08 June and 05 July, showing major differences in the presentation of CH97/+ that mean it should be a more impactful and longer-lasting feature on this pass, although it has yet to appear at STEREO A.



Radio Blackouts - X-Ray Flares:

The chances of significant X-ray activity are on the increase, with the background flux recorded at GOES16 now near the C boundary, perhaps helped by new arrivals over the eastern solar horizon, while the diminutive AR3047 produced a near M-class flare in the past 24 hours.

The front side balance of sunspot should show a net increase in the four days, with up to three returning sunspot groups due over the northeastern limb and no groups of significance departing. Any contribution from eastern limb arrivals will be judged as and when they present for analysis.

C-class flares are now Expected, while M-class have been revised upwards to a daily Slight Chance.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	15	15	15	15
Very Active	R3 to R5 X Class	No	1	1	1	1

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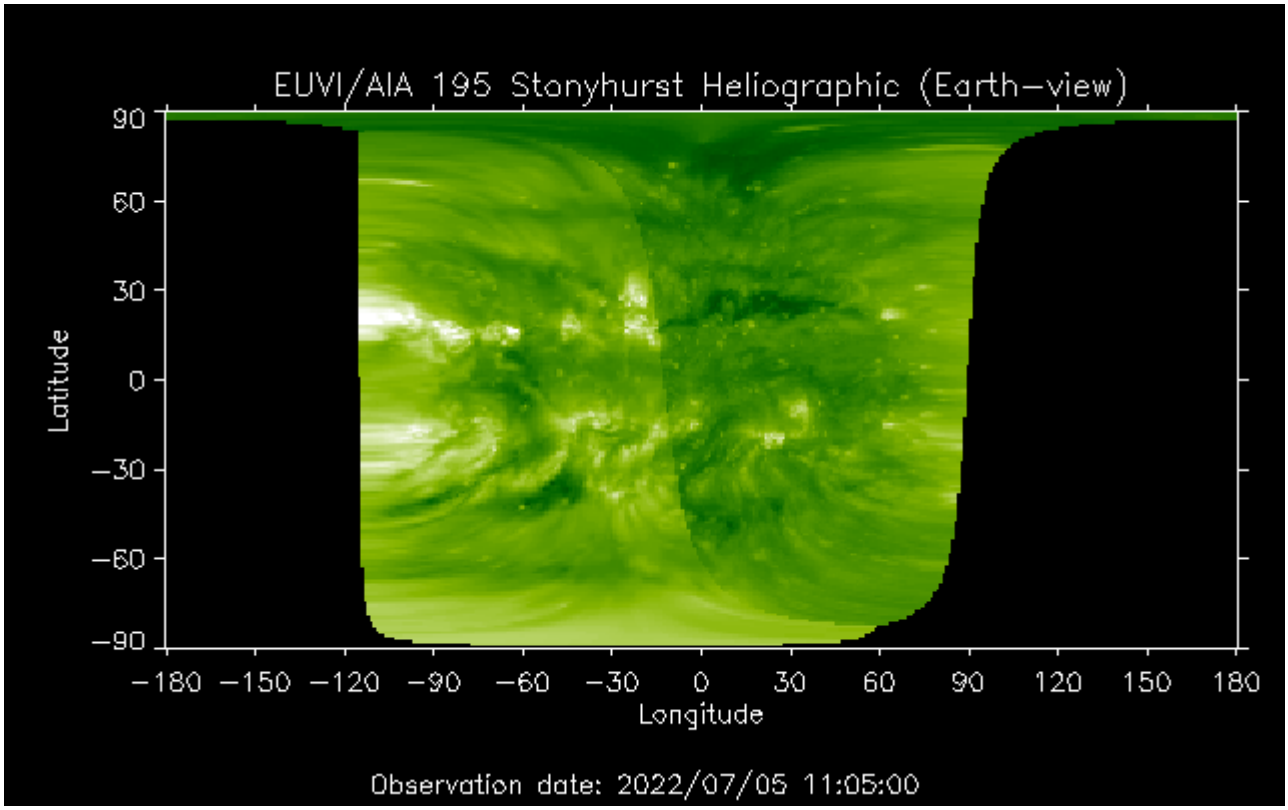
Figure 3: Cylindrical projection of the sun in 195 Angstroms, showing a possible train of bright flux regions to arrive over the northeastern limb through the midweek UTC period.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels, and will most likely remain at this level through the period, in the absence of any significant sunspot development. AR3047's near M-class flare does not appear to have produced any proton enhancement at the time of writing, and this is the sole occupant of the western solar hemisphere.

Radiation Storms Probability (Exceedance)	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC) (%)**	**Day 2 (00-24 UTC) (%)**	**Day 3 (00-24 UTC) (%)**	**Day 4 (00-24 UTC) (%)**
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has been at Normal Background levels. Electron flux is likely to maintain a similar level oscillation initially, however, there is a likely increasing chance of high (1e3 pfu) flux levels being reached during the forecast period due to anticipated high speed stream influence of CH97/+.

Electron fluence is currently well below the Active threshold. Fluence is currently considered most likely to remain below the Active threshold through the period, although this carries a degree of uncertainty due to the significant difference in coronal hole extent compared to the previous rotation. An upward trend is assessed as being likely following anticipated coronal hole connection but with low confidence for the magnitude of this.

Recurrence is not considered to be a very good guide at present as a result of the much-changed presentation of CH97/+. REFM maintains very low Fluence values throughout with no upward trend, with a more reactive second half of the week instead preferred.

GEO Electron Environment	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	5	10	30	30
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	5	5

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